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(71) Applicant: **Tamglass Engineering Oy**
SF-33730 Tampere (FI)

(72) Inventors:
- **Vitkala, Jorma**
  FIN-33820 Tampere (FI)
- **Vehmas, Jukka**
  FIN-33270 Tampere (FI)
- **Lehto, Esko**
  FIN-36240 Kangasala (FI)

(74) Representative: **Grünecker, Kinkeldey,**
Stockmair & Schwanhäusser
Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Method for heating glass sheets to be tempered or heat-strengthened

(57) The invention relates to a method for heating glass sheets to be tempered or heat-strengthened, in which method glass sheets are heated in a preheating furnace (1) by applying a hot-air blast and convection heating produced thereby to the opposite sides of a glass sheet and the preheated glass sheet is transferred from the preheating furnace (1) into a radiation heating furnace (2) for heating the glass sheet to a tempering temperature. During the convection heating of a glass sheet, the rotating speed of a hot-air fan (5) is increased while adjusting the heating effect of heating resistances (6) so as to maintain the temperature of blasted air substantially constant. Thus, the diminishing temperature difference between glass and air is compensated for by controlling the coefficient of heat transfer.

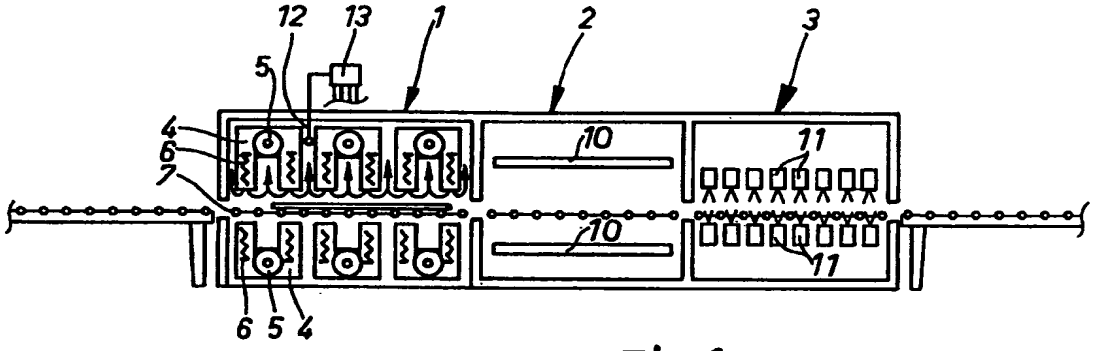

Fig.1

EP 0 721 922 A1

Description

The present invention relates to a method for heating glass sheets to be tempered or heat-strengthened, in which method glass sheets are heated in a preheating furnace by applying a hot-air blast and convection heating produced thereby to the opposite sides of a glass sheet and the preheated glass sheet is transferred from the preheating furnace into a radiation heating furnace for heating the glass sheet to a tempering temperature.

In such prior known tempering furnaces, a drawback involved in preheating is that the heating efficiency deteriorates as the glass temperature rises. Thus, the preheating station is not capable of reaching a very high temperature or, alternatively, the heating time increases unacceptably.

An object of the invention is to improve this type of tempering method, such that the preheating can be intensified and expedited even though the air temperature is maintained substantially constant.

This object is achieved on the basis of the characterizing features set forth in the annexed claims 1 and 2.

The invention will now be described in more detail by way of an example with reference made to the accompanying drawing, in which

fig. 1 is a schematic vertical section, showing a tempering furnace for implementing a method of the invention and

fig. 2 shows schematically a detail in the preheating station of the furnace.

The furnace comprises a preheating furnace 1 operating on the convection heating principle, a radiation heating furnace 2, and a cooling station 3 for tempering or heat-strengthening. The radiation heating furnace 2 is provided with resistance elements 10 on either side of a roll conveyor or just above a roll conveyor. The chilling station 3 is provided with nozzle boxes 11 above and below a roll conveyor. The question may be about the tempering or heat-strengthening of flat glass or bent glass.

Above and below a conveyor consisting of rolls 7, the preheating furnace 1 includes nozzle boxes 4 which are fitted with fans 5 for circulating hot air between the furnace interior and nozzles located adjacent to the surface of a glass sheet. The nozzle boxes 4 are provided with heating resistances 6 between the fan 5 and nozzle orifices. A temperature sensor 12 measuring the air temperature of furnace 1 uses a control device 13 for regulating the power received by the resistances 6, such that the air temperature in the furnace remains substantially constant at a certain set value. The air temperature is maintained within a range of 400-500°C, preferably at about 450°C. This temperature is about 100°C higher than in conventional preheating furnaces operating on the convection principle.

An essential feature in the invention is that the temperature difference between the glass and the furnace air diminishing upon the heating of glass is compensated for by controlling the coefficient of heat transfer of convection blast. According to the invention, this control of the coefficient of heat transfer is effected by increasing the rotating speed of fans 5 included in nozzle boxes 4 as the glass is heating. The rotating speed may increase to about 6-fold during the course of preheating.

The primary reason why the air temperature must be maintained constant is to prevent the heat expansion of furnace structures. The preheating must not involve at any stage too high a coefficient of heat transfer since the temperature difference between the core and the surface of glass must be maintained smaller than the temperature difference at which the glass breaks. Typically, this temperature difference is less than 50°C. A method of the invention enables the maintenance of a coefficient of heat transfer throughout the preheating process at an optimally high level, such that it is not too high at the start and ineffectively low at the end.

An additional advantage gained by the invention is that, when preheating coated and reflecting glasses, the coefficients of heat transfer for both surfaces can be adjusted separately by adjusting separately the rotating speeds of hot-air fans blasting to the opposite surfaces of the glass so as to produce different coefficients of heat transfer for the opposite surfaces of the glass. The inverter operation of fan motors 8 controls automatically the rise of rotating speed, whereby a controller 9 can be used for setting the rotating-speed rising rates adapted to various glass thicknesses.

Claims

1. A method for heating glass sheets to be tempered or heat-strengthened, in which method glass sheets are heated in a preheating furnace (1) by applying a hot-air blast and convection heating produced thereby to the opposite sides of a glass sheet and the preheated glass sheet is transferred from the preheating furnace (1) into a radiation heating furnace (2) for heating the glass sheet to a tempering temperature, **characterized** in that, in view of adjusting the coefficient of heat transfer for convection heating, the rotating speed of a hot-air fan (5) is increased for increasing the volume flow of blast as the glass temperature rises.

2. A method for heating glass sheets to be tempered or heat-strengthened, in which method glass sheets are heated in a preheating furnace (1) by applying a hot-air blast and convection heating produced thereby to the opposite sides of a glass sheet and the preheated glass sheet is transferred from the preheating furnace (1) into a radiation heating furnace (2) for heating the glass sheet to a tempering temperature, **characterized** in that, during the convection heating of a glass sheet, the rotating speed

of a hot-air fan (5) is increased while adjusting the heating effect of heating resistances (6) so as to maintain the temperature of blasted air substantially constant.

3. A method as set forth in claim 1 or 2, **characterized** in that the temperature of blasted air is maintained within the range of 400 - 500°C, preferably at about 450°C.

4. A method as set forth in any of claims 1 - 3, **characterized** in that a fan motor (8) is controlled by means of an inverter (9) which is adapted to rise the rotating speed according to a preset program depending on the glass thickness.

5. A method as set forth in any of claims 1 - 3, **characterized** in that the rotating speeds of the hot-air fans (5) blasting to the opposite glass surfaces are adjusted separately for producing, if necessary, different coefficients of heat transfer for the opposite glass surfaces.

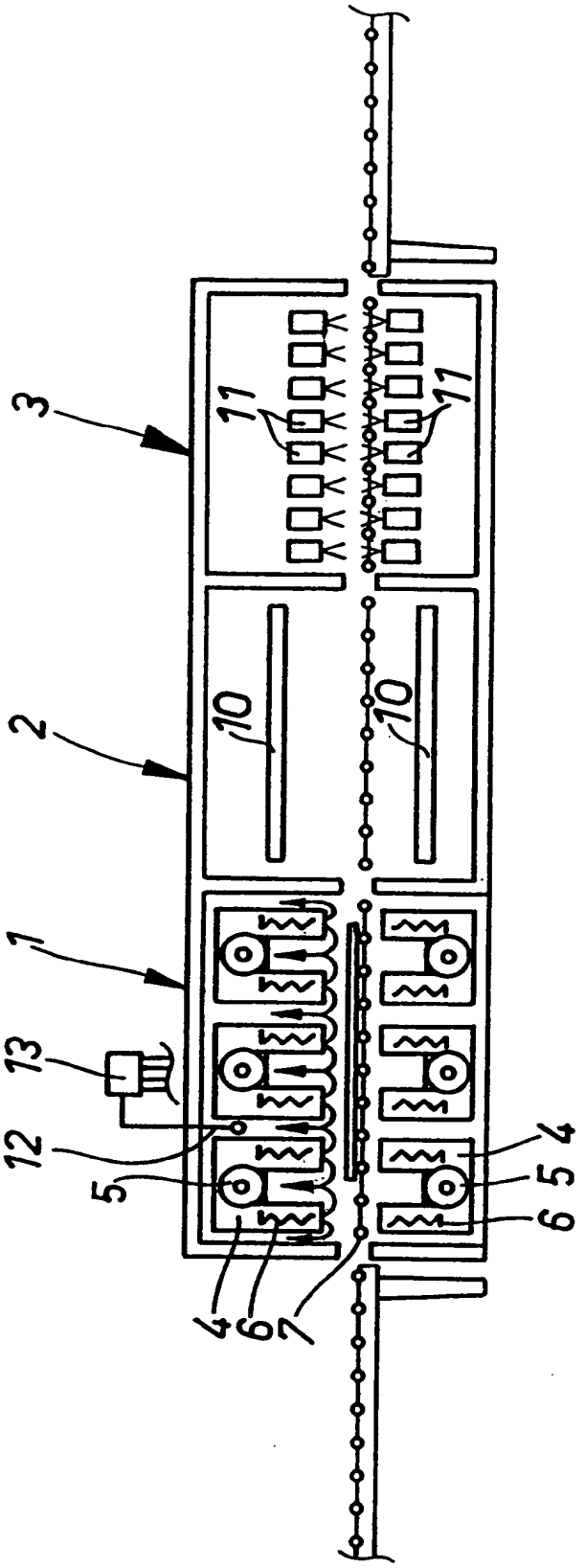

Fig. 1

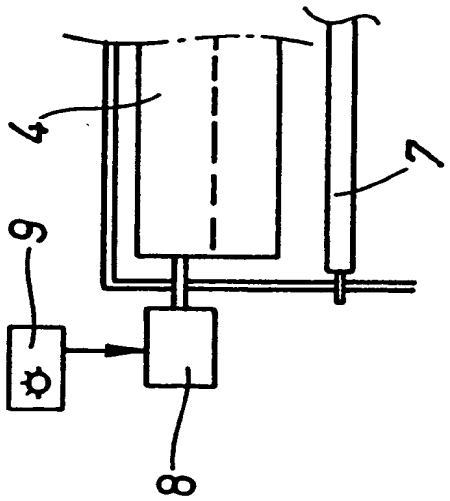

Fig. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 9843

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP-A-0 592 862 (TAMGLASS ENGINEERING OY) * claims 1,2; figure 1 *	1,2,5	C03B29/08
A	US-A-5 085 580 (P.T.REUNNAMAKI) * column 2, line 36 - line 62; figure 1 *	1,2	
A	WO-A-93 06052 (TAMGLASS ENGINEERING OY) * page 2, paragraph 5 - page 3, paragraph 2; figure 1 *	1,2	
A	US-A-5 232 482 (T.LAAKSO ET AL.) * column 3, line 37 - line 51; figure 7 *	1,2	
A	DE-A-14 71 831 (GLAVERBEL) * page 8, paragraph 2 - page 9, paragraph 1; figure 2 *	1,2	
A	EP-A-0 058 529 (H.A.MCMASTER) * claims 1,8; figures 2,8 *	1,2	
A	EP-A-0 448 983 (WSP GMBH) * column 4, line 57 - column 5, line 25; figures 1,4 *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6) C03B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 March 1996	Stroud, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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